STRENGTH OF SOFT CLAY REINFORCED WITH 16MM CRUSHED COCONUT SHELL COLUMN

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SUPERVISOR’S DECLARATION

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor Degree of Civil Engineering.

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STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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ABSTRACT

Stone column could be used as a ground improvement technique where a portion of soft soil is replaced with granular material such as stone or sand. The benefit of using stone columns in low strength soil has been proved as an efficient method to improve bearing capacity and reduce settlement of soft soils. This study was aimed to investigate the improvement in shear strength of soft clay by embedded with single crushed coconut shell column. This paper was done by determine the height penetration ratio of a single crushed coconut shell column on shear strength characteristics. Unconfined Compression Test (UCT) was conducted for 4 batch kaolin samples including control sample in order to determine the shear strength. The research variable are diameter and height of crushed coconut shell column which under a concept of critical length of column. The increment of shear strength by embedded with crushed coconut shell column are 22.19%, 12.50% and 6.32% with 10.24% area replacement ratio at column penetration ratio of 0.60, 0.80 and 1.00 respectively. From the result obtained, the relationship of the increment of shear strength with the various column penetration show different pattern.

ABSTRAK

Medan batu boleh digunakan sebagai teknik pembaikan tanah di mana sebahagian tanah lembut diganti dengan butiran bahan seperti batu atau pasir. Manfaat menggunakan tiang batu di tanah yang kekuatannya rendah telah membuktikan sebagai satu kaedah yang berkesan untuk meningkatkan keupayaan galas lapisan dan mengurangkan penyelesaian tanah lembut. Tujuan kajian ini adalah untuk menyiasat peningkatan kekuatan ricih tanah liat lembut yang tertanam dengan bentuk satu pellet tiang tempurung kelapa hancur. Kajian ini telah dilakukan oleh menentukan kesan kawasan nisbah gantian dan nisbah penembusan lajur bentuk satu tempurung kelapa hancur mengenai ciri-ciri kekuatan ricih. Ujian Triaxial mampatan unconfined (UCT) telah dijalankan untuk sampel kaolin batch 4 termasuk sampel kawalan bagi menentukan kekuatan ricih. Pembolehubah kajian adalah garis pusat dan ketinggian tiang tempurung kelapa hancur yang di bawah konsep tempoh kritikal lajur. Kenaikan kekuatan ricih dengan tertanam dengan kolum tempurung kelapa hancur adalah 22.19%, 12.50% dan 6.32% dengan 10.24% kawasan penggantian nisbah dengan nisbah penembusan tiang 0.60, 0.80 dan 1.00 masing-masing. Daripada hasil yang diperolehi, keputusan yang didapati ada hubungan antara kenaikan kekuatan ricih dengan penembusan lajur pelbagai menunjukkan pola yang berbeza.

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LIST OF SYMBOLS

A_c	Area of a column
A_s	Area of a sample
H_c	Height of a column
H_s	Height of a sample
V_c	Volumes of a column
V_s	Volumes of a sample
D_c	Diameter of a column
Si	Immediate settlement
Sc	Primary consolidation
τ	Shear strength of the soil
σ	Effective normal stress
W_L	Liquid limit
W_p	Plastic limit
I_p	Plastic Index
W_{opt}	Optimum water content
q_u	Deviator stress
S_u	Undrained shear stress
ΔS_u	Improvement undrained shear strength
ρ_d	Dry density
R^2	Correlation cohesion

LIST OF ABBREVIATIONS

AASHTO	American Association of State Highway and Transportation Officials
ASTM	American Society of Testing Material
BS	British Standard
BSCS	British Soil Classification System
CS	Coconut Shell
CSA	Coconut Shell Ash
EDS	Energy Dispersive Spectrometry
EPF	Employee Provided Fund
FHWA	Federal Highway Administration
MIT	Massachusetts Institute of Technology
ML	Low Plasticity Silt
USCS	Unified Soil Classification System
USDA	US Department of Agriculture
WV	West Virginia

CHAPTER 1

INTRODUCTION

1.1 Background

Solid waste is one of the three major environmental problems in Malaysia. It plays a significant role in the ability of Nature to sustain life within its capacity. In 2013, a study by government showed the average Malaysian produced 800 gram of solid waste a day according to Ismail (2014). People living in urban areas produced 1.25kg of waste a day thus this led to an estimated 30,000 to 33,000 tonnes of waste being produced a day in 2013 compared to 22,000 tonnes of solid waste produced daily in 2012. Deputy Urban Wellbeing, Housing and Local Government Minister, Datuk Halimah Mohd Sadique said in ‘The Malay Mail’, the ministry viewed this as a major problem because the latest figure exceeded the government’s projected waste production of 30,000 tonnes daily by 2020.

Sreenivasan & Govindan (2012) said that the amount of waste generated continues to increase due to the increasing population and development, and only less than 5% of the waste is being recycled. Despite the massive amount and complexity of waste produced, the standards of waste management in Malaysia are still poor. These include outdated and poor documentation of waste generation rates and its composition, inefficient storage and collection systems, disposal of municipal wastes with toxic and hazardous waste, indiscriminate disposal or dumping of wastes and inefficient utilization of disposal site space. In order to overcome this problem, our Prime Minister, Datuk Seri Najib Razak announced that Malaysia towards a clean and sustainable nation in 11th Malaysia Plan (Pauzee, 2016). “Achieving growth that is inclusive, sustainable, growth with equity, competitive and progressive” said Datuk Seri Najib Razak. Furthermore, in 11th Malaysia Plan, strategic thrusts number six are pursuing green growth for sustainability and resilient which are more focus to adopting the sustainable consumption and production by managing waste holistically through better coordination, encouraging reuse reduce recycle (3R) and using waste as resources for industries. In major transformation initiative number four is the waste technology utilization for effective services and recovery. Figure 1.1 shows the waste recovery through new technology.

Figure 1.1 : Waste recovery through new technology
Source : Pauzee (2016)

Referred in Figure 1.1, organic waste facilities were included, thus organic waste can be used in engineering industries for sustainable construction. One of the organic materials used are coconut. Coconuts are known for their great versatility, as evidenced by many traditional uses, ranging from food to cosmetics. The use of coconut by-products has been a long time source of income for some people in the country (Ganiron, 2013). In Malaysia, coconut is one of the fruit crops which produce the highest amount of consumption per capita, therefore increasing the amount of waste material from coconuts. Coconut fiber and coconut shell are organic waste products obtained in the processing of coconut oil and coconut milk which are available in large quantities in the tropical regions of the world, most especially in Africa, Asia and America (Achaw, 2008). The coconut has many uses. The fruit itself is used in many industries not only as food but for other uses as well (Reddy, 2015). The energy industry has also seen the potential of the coconut as the coco-diesel was created as an alternative to the fossil fueled oils the Philippines import (Ganiron, 2013). Aside from its ornamental use, the shell has been powdered and used as glues and its charcoal form was used as activated carbon and used as a filter material for masks and air-conditioning systems (Esquenazi, 2002). In the construction industry, the husk is used as a mat in preventing the erosion of soils. Boards are created from the husk of the coconut by acquiring the fibers from the husk (Babel, 2004). Figure 1.2 shows coconut production in Asia Pacific region in 2014, by country (in thousand tons).

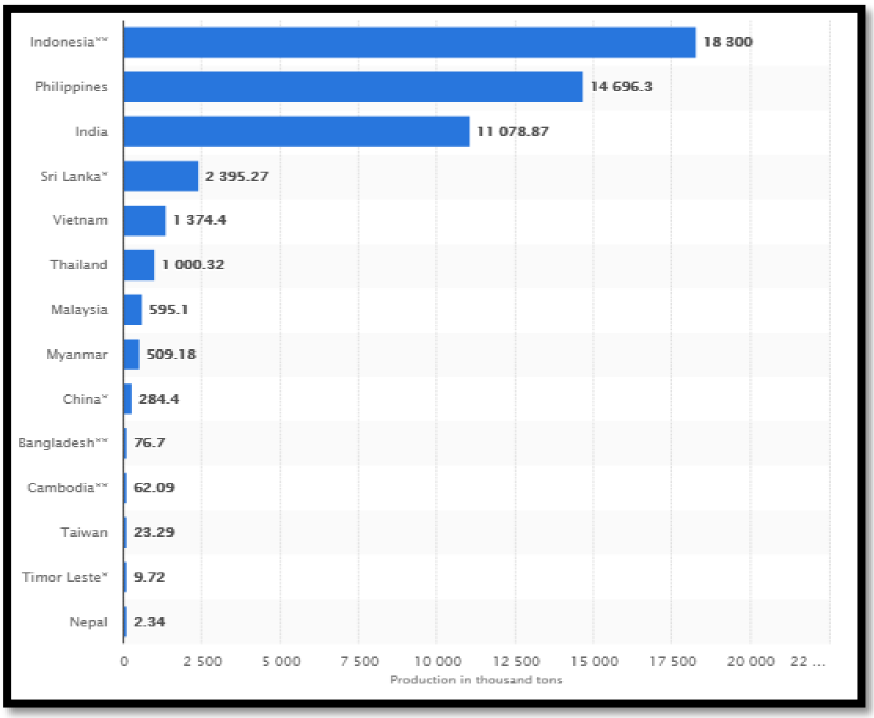

Figure 1.2: Coconut production in Asia Pacific region in 2014, by country (in thousand tons)

Source: Ganiron (2013)

Construction on soft ground area or as known as soft clay soil is a great challenge in the field of geotechnical engineering and always been a challenging task for engineers in Malaysia. The construction over soft clay soil is increasing due to lack of suitable land for infrastructures and other developments (Chin, 2005). Thus many engineering problems in the form of slope instability, bearing capacity failure or excessive settlement could occur either during or after the construction phase due to low shear strength and high compressibility of this soil. Instability of the ground during construction works had caused delay and cost overrun in completion of the project in Selangor, whereas occurrence of continuous post construction settlement had affected the integrity and serviceability of the building in Sabah (Khairul et al., 2006). Expansive soils causing more damage to structures, particularly light buildings and pavements, than any other

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